

FLUCTUATIONS IN HIMALAYAN GLACIERS.<sup>1</sup>

NEARLY half a century ago the glaciers of the Alps began to shrink. Their retreat was most rapid in the decade following 1860; since then it has been generally slow, and of late years the ends have been mostly stationary or oscillating. Traditional and other evidence exists of earlier fluctuations, and it suggests that the cycle of change is completed in about half a century. For some time past these fluctuations have been watched in various places, and an International Commission of Glaciers is now occupied in collecting and systematising evidence bearing on the secular and annual oscillations of the ice.

The glaciers in other parts of the world—the Caucasus, parts at least of the Himalayas, and of North America, even of the southern hemisphere—show signs of a recent retreat. As this is indicative of more than local causes, extended and accurate observations have become more than ever desirable. In 1905, Mr. Douglas Freshfield, so well known as a scientific geographer and explorer, urged the authorities in India to record the secular movements of the principal Himalayan glaciers. They undertook the task, and charged the Geological Survey with the collection and distribution of the observations. Last year twelve glaciers were examined, six in the Kashmir region, surveyed by Mr. H. H. Hayden; two in the Lahaul, and four in the Kumaon.

The report before us gives a general account of each glacier and its past history, so far as this can be ascertained, and describes the marks placed to measure its future movements, with sketch-maps and reproduced photographs. In the Hunza region, the glaciers reach lower levels—from seven to eight thousand feet—than in the Lahaul and the Kumaon, where they do not descend below about eleven thousand feet. They may, as usual, be divided into two classes—those flowing in valleys transverse to the trend of the range, and those the course of which is approximately parallel to it; the former, which have the more rapid slope, being the shorter, but descending lower; the latter, such as the Hispar and the Biafo, which attain lengths of twenty-four and thirty-nine miles respectively, being arrested at about ten thousand feet.

Of the six observed, no certain evidence of gain or loss could be obtained about the Barche and Minapin. The great Hispar glacier, traversed by Sir Martin Conway in 1892, has since then slightly retreated. The Hinarche glacier, the lower part of which was explored by the same traveller, has evidently advanced. This, however, may not mean much, for the people of the country assert that it fluctuates in a cycle of six years, advancing and retreating over a distance of some three hundred yards, and was at its maximum when Mr. Hayden saw it. The Yengutsa glacier, however, has gained about two miles in length since Conway's visit, and this, according to native testimony, by a sudden advance about two years

<sup>1</sup> Records of the Geological Survey of India, vol. xxxv., parts iii. and iv. 1907. Containing a Preliminary Survey of Certain Glaciers in the North-west Himalaya, by Officers of the Geological Survey of India. Part iii., Notes on Certain Glaciers in North-west Kashmir, by H. H. Hayden. Pp. 15; 23 plates. Part iv., Glaciers in Lahaul, by H. Walker and E. H. Pascoe; Glaciers in Kumaon, by G. de P. Cotter and J. Caggin Brown. Pp. ix+18; 26 plates. (Published by Order of the Government of India, 1907.) Price 1 rupee each.

before Mr. Hayden's visit, since when it has been stationary. The Hassanabad glacier, a year earlier, made a yet more rapid and extensive progress, for in the course of two and a half months its length was increased, on the lowest estimate, by six miles, but it is now stationary. The chief official in Hunza also stated that many years ago it had reached, and then retreated from, its present position. The accompanying illustration, from one of the sixteen excellent reproduced photographs in the first part, shows the end of the glacier at the time of the surveyors' visit.

The two glaciers in Lahaul, surveyed by Messrs. Walker and Pascoe, are both in the Chandra valley—one of them, the Sonapani, ending at about 13,000 feet above sea level, has in advance of it a desiccated lake-bed dammed by an old terminal moraine, below which are three similar moraines. The other glacier, the Bari Shigri—the boulder covered—has been already noticed more than once by travellers, and their accounts show it to have retreated considerably during the last seventy years. Of the four glaciers in Kumaon, examined by Messrs. Cotter and Brown, the Pindari is already well known to tourists. It descends from lofty peaks, but the



Hassanabad Glacier.

ice appears to move rather slowly, and is not much crevassed. It is said to be retreating, but the surveyors could not succeed in obtaining any exact details. The Milam glacier was described early in the last century as the source of the Ganges. It is now about twelve miles long, but, as old moraines show, was once larger. The terminal ice-cave, about fifty years ago, was some 800 yards in advance of its present position. The Shankalpa glacier is much crevassed, and is probably retreating, though no old moraines are found much in advance of its present snout. Of the fourth, the Poting glacier, old terminal moraines exist lower down the valley, but no evidence was found of a recent retreat. Here also the excellent photographs and sketch-maps will make future movements of the ice easily detected.

These fluctuations, whenever they may occur, must be due either to an increased supply on the upper snow-fields, or to a diminished waste of the ice on the lower parts, or to a combination of both; though sometimes, as in the case of the Glacier Blanc and Glacier Noir in the Pelvoux district of Dauphiné,<sup>1</sup> one ice stream may be advancing while another is in retreat. That,

<sup>1</sup> C. Jacob and G. Flusin, "Étude sur le Glacier Noir et le Glacier Blanc" (Commission française des Glaciers), 1905, ch. v.

however, may be a consequence either of a difference of alimentation or of the rate at which the ice is moving. Thus long and careful observations are necessary of the latter, of the nature of the advance or retreat, and of other matters, before sufficient data can be obtained to allow of the results obtained in different regions being compared, and their bearing on questions of general meteorology ascertained, but the investigation now begun in the vast northern mountain barrier of Hindustan must ultimately prove to be highly valuable.

T. G. BONNEY.

#### TIDAL INVESTIGATIONS IN CANADA.

THERE are few countries which possess so large an extent of navigable land-locked waters as does Canada. In such situations the tidal currents are apt to assume great importance, and the prediction of the tides is a task of great difficulty. The Canadian Government has naturally paid much attention to this complex subject, and they are fortunate in having so able an officer as Mr. W. Bell Dawson to place in charge of the operations.

In a paper on "The Currents of the Belle Isle Strait" (Government Printing Office, Ottawa, 1907), Mr. Dawson gives an account of the investigations carried out in the seasons of 1894 and of 1906. The run of the tide in the strait in places is sometimes apparently capricious, but Mr. Dawson shows that in many cases the abnormalities become explicable when properly examined. The results should prove of much value to mariners.

Mr. Dawson has also contributed a paper on "Variations in the Leading Features of the Tide in Different Regions" to the Royal Astronomical Society of Canada (July-August).

It is obvious that in the vast tract of navigable Canadian waters, the cost would be prohibitive of erecting tide-gauges at all the places at which tide-tables are wanted. Hence the calculation of the tides by reference to neighbouring harbours becomes a matter of necessity. It is a subject to which Mr. Dawson has already paid much attention. The ordinary rough rule is to multiply the range of tide at the port of reference by a constant factor, and to apply a constant correction to the times of high and low water. But such a simple rule often leads to enormous errors of prediction. Now Mr. Dawson shows that this factor and correction of time should not be regarded as constant, but should be taken as variable with the position of the moon.

The three points in which the position of the moon is influential are phase, declination, and parallax. These undergo variations in months of slightly different lengths, called the synodic, the tropical, and the anomalistic months. The corrections should be dependent on all these three periods, and thus they acquire a considerable amount of complexity. The most interesting point in Mr. Dawson's investigation is that he finds that, in some cases, it is one of the three factors which is dominant, and elsewhere it is another. So much is this the case that it is often possible to omit all corrections except those which are periodic in one of the three months. The determination of the dominant factor appears to be empirical, and no physical explanation is assigned for this curious conclusion. May we not suspect that when one or two of the monthly variabilities in the corrections are evanescent as regards time and height of high and low water, they are really affecting the tidal currents?

In any case these partially empirical corrections are found to be satisfactory in providing fairly trustworthy tide-tables, by reference to ports where there are tide-gauges and directly computed tide-tables.

G. H. D.

#### EDUCATION AND RESEARCH IN INDIA.

THE battle between those who believe the sole duty of our professors in universities, colleges and other high educational institutions is to teach, and the best professor one who devotes the whole of his time to teaching; and those who believe that the highest and most fertile kind of teaching is that carried on by a professor who is an investigator as well as a teacher, has been fought out on many occasions and in many places.

Fortunately the latter view in late years has largely prevailed over the former, though the battle has still to be actively carried on in many places. The universities of Europe, at all events those which are the most progressive and of greatest importance, have accepted the fact that in the selection of their professors they must now take only such men as have given distinct proof of capacity for original work in one or other of the great departments of knowledge, and who may be expected to continue their original researches at every possible opportunity.

Unfortunately, in England this spirit has not always been acted on, and the condition of a good many of the institutions devoted to the highest culture is in the matter of research most unsatisfactory, and compares most unfavourably with institutions of similar grade on the Continent.

Nor, indeed, is this lack of original work in England confined to what may be called centres of the highest intellectual activity, but it largely pervades educational and technical institutions of all grades, and it is stated that in many cases where the management of such institutions is in the hands of committees, whose members are distinguished mainly by their success in trade, original research on the part of the staff is practically barred, and, if a professor or teacher is known to be an enthusiastic investigator, he is at once considered to be one who is not doing full justice to the students entrusted to his charge.

It is to be hoped that such instances will become more and more rare as the proper functions of a teacher are better understood, and it is for our universities, and for all educational institutions more or less controlled or influenced by Government, to take the lead in this matter and to insist on the inseparability of research from the highest branches of teaching.

An opportunity of taking such a stand and of doing an almost incalculable amount of good to the higher teaching of a country now appears to lie in the hands of the Indian Government. For a good many years India may be said to have been suffering from an educational unrest, for it was understood by all those who had studied the subject that Indian education had been working on unfortunate lines. Lord Curzon, during the time he was Viceroy, was the first who boldly faced a very difficult problem, and under his direction Indian education was placed upon a much more satisfactory basis. The changes brought about by Lord Curzon's action were very numerous; primary education was largely extended and made more practical, female education was fostered in every possible way, secondary education was also improved, and, lastly, university education was dealt with. Under a new Indian University Act a complete set of new regulations has been prepared, and speaking generally of these regulations it may be said that they have aimed at, first, the influencing of the characters of the students in the colleges and high schools, and, secondly, at securing a practical rather than a book knowledge of the subjects dealt with.

It may also be mentioned that, in cases where a science is being studied, the regulations require each student to have had personal practical instruction